APPENDIX B
AMS-02 Thermal Control System (TCS)
Heater Properties

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
PDS, Group 1, Bus A	100	113	126.5	Open-On-Rise -10ºC / +5ºC	dual heater element	1	2 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	These heaters are thermostatically regulated. Two types of control thermostats are foreseen in this case. Open-on-rise thermostats: this type is used to disable the heater system when the PDS and the surrounding electronics units have reached operative temperature ranges. Close on rise thermostats: this type is used to properly control the overall switch on sequence. They are needed to control the amount of heat transferred to the radiator panel by regulating the number of patches that are enabled. HPs, being their performances a function of the working temperature, could not transfer a higher heat than the one rated at the specific temperature. To avoid their drying out, the electrical heating circuit have been designed to enable progressively the patches (via close-on-rise thermostats), increasing then HP temperature and the amount of heat introduced" disabled
PDS, Group 2, Bus A	100	113	126.5	Open-On-Rise -10ºC / +5ºC	dual heater element	1	2 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 3, Bus A	100	113	126.5	Open-On-Rise -10ºC / +5ºC	dual heater element	1	2 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 4, Bus A	100	113	126.5	Open-On-Rise -10ºC / +5ºC, Close-On-Rise -40ºC /-50ºC	dual heater element	1	4 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 5, Bus A	100	113	126.5	Open-On-Rise -10ºC / +5ºC, Close-On-Rise -40ºC /-50ºC	dual heater element	1	4 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 6, Bus A	100	113	126.5	Open-On-Rise -10ºC / +5ºC, Close-On-Rise -30ºC /-40ºC	dual heater element	1	4 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 7, Bus A	100	113	126.5	Open-On-Rise -10ºC / +5ºC, Close-On-Rise -30ºC /-40ºC	dual heater element	1	4 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
PDS, Group 1, Bus B	88.2 (@ 106.1V on PVGF) 100 (@ 113V on ISS)	106.1 (PVGF) 113 (ISS)	126.5	Open-On-Rise -10ºC / +5ºC	dual heater element	1	2 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	These heaters are thermostatically regulated. Two types of control thermostats are foreseen in this case. Open-on-rise thermostats: this type is used to disable the heater system when the PDS and the surrounding electronics units have reached operative temperature ranges. Close on rise thermostats: this type is used to properly control the overall switch on sequence. They are needed to control the amount of heat transferred to the radiator panel by regulating the number of patches that are enabled. HPs, being their performances a function of the working temperature, could not transfer a higher heat than the one rated at the specific temperature. To avoid their drying out, the electrical heating circuit have been designed to enable progressively the patches (via close-on-rise thermostats), increasing then HP temperature and the amount of heat introduced" disabled
PDS, Group 2, Bus B	88.2 (@ 106.1V on PVGF) 100 (@ 113V on ISS)	106.1 (PVGF) 113 (ISS)	126.5	Open-On-Rise -10ºC / +5ºC	dual heater element	1	2 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 3, Bus B	88.2 (@ 106.1V on PVGF) 100 (@ 113V on ISS)	106.1 (PVGF) 113 (ISS)	126.5	Open-On-Rise -10ºC / +5ºC	dual heater element	1	2 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 4, Bus B	88.2 (@ 106.1V on PVGF) 100 (@ 113V on ISS)	106.1 (PVGF) 113 (ISS)	126.5	Open-On-Rise -10ºC / +5ºC, Close-On-Rise -40ºC /-50ºC	dual heater element	1	4 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 5, Bus B	88.2 (@ 106.1V on PVGF) 100 (@ 113V on ISS)	106.1 (PVGF) 113 (ISS)	126.5	Open-On-Rise -10ºC / +5ºC, Close-On-Rise -40ºC /-50ºC	dual heater element	1	4 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 6, Bus B	88.2 (@ 106.1V on PVGF) 100 (@ 113V on ISS)	106.1 (PVGF) 113 (ISS)	126.5	Open-On-Rise -10ºC / +5ºC, Close-On-Rise -30ºC /-40ºC	dual heater element	1	4 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	
PDS, Group 7, Bus B	88.2 (@ 106.1V on PVGF) 100 (@ 113V on ISS)	106.1 (PVGF) 113 (ISS)	126.5	Open-On-Rise -10ºC / +5ºC, Close-On-Rise -30ºC /-40ºC	dual heater element	1	4 thermostats in series	No, by analysis	Glued to back side of radiator over heat pipes dedicated flanges	

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Tracker Radiator (including condensers) – Ram – BUS A	155.7	113 @ ISS (we are not going to operate these heaters in hand-off)	126.5	-25°C / -15°C	Single element heater	37	3 thermostats in series+PDS Line A10	No	Glued to back side of radiator near heat pipes and on TTCS condensers	Needed to defreeze ammonia heat pipes and CO2 prior to Tracker operation. Will be disabled after start-up.
Tracker Radiator (including condensers) – Ram – BUS B	155.7	see above	126.5	-25°C / -15°C	Single element heater	37	3 thermostats in series+PDS Line B10	No	Glued to back side of radiator near heat pipes and on TTCS condensers	Needed to defreeze ammonia heat pipes and CO2 prior to Tracker operation. Will be disabled after start-up.
Tracker Radiator (including condensers) – Wake - BUS A	155.7	see above	126.5	-25°C / -15°C	Single element heater	55	3 thermostats in series+PDS Line A4	No	Glued to back side of radiator near heat pipes and on TTCS condensers	Needed to defreeze ammonia heat pipes and CO2 prior to Tracker operation. Will be disabled after start-up.
Tracker Radiator (including condensers) – Wake - BUS B	155.7	see above	126.5	-25°C / -15°C	Single element heater	55	3 thermostats in series+PDS Line B4	No	Glued to back side of radiator near heat pipes and on TTCS condensers	Needed to defreeze ammonia heat pipes and CO2 prior to Tracker operation. Will be disabled after start-up.
Main Radiator – Ram, Set 1, Group 1, Bus A	88.2	113	126.5	-8°C / 0°C	Dual element heater	4	2 thermostats in series+PDS Line 2A	No, by analysis	Double sided heaters glued to back side of radiator (2) and JPD side walls (2)	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 1, Group 2, Bus A	78.2	113	126.5	-8°C / 0°C	Dual element heater	20	2 thermostats in series+PDS Line 2A	No, by analysis	Double sided heaters glued to JT crate main walls (10 x 2)	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 1, Group 3, Bus A	68.6	113	126.5	-8°C / 0°C	Dual element heater	20	2 thermostats in series+PDS Line 2A	No, by analysis	Double sided heaters glued to J crate main walls (10 x 2)	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Main Radiator – Ram, Set 1, Group 4, Bus A	58.8	113	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 2A	No, by analysis	Double sided heaters glued to back side of radiator	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 1, Group 5, Bus A	88.2	113	126.5	-8°C / 0°C	Dual element heater	3	2 thermostats in series+PDS Line 2A	No, by analysis	Double sided heaters glued to back side of radiator	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 1, Group 6, Bus A	88.2	113	126.5	-8°C / 0°C	Dual element heater	3	2 thermostats in series+PDS Line 2A	No, by analysis	Double sided heaters glued to back side of radiator	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 2, Group 7, Bus A	78.4	113	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 5A	No, by analysis	Double sided heaters glued to back side of radiator	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 2, Group 8, Bus A	78.4	113	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 5A	No, by analysis	Double sided heaters glued to back side of radiator	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 2, Group 9, Bus A	78.4	113	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 5A	No, by analysis	Double sided heaters glued to back side of radiator	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 2, Group 10, Bus A	78.4	113	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 5A	No, by analysis	Double sided heaters glued to back side of radiator	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.
Main Radiator – Ram, Set 2, Group 11, Bus A	39.2	113	126.5	-8°C / 0°C	Dual element heater	1	2 thermostats in series+PDS Line 5A	No, by analysis	Double sided heaters glued to back side of radiator	Needed when electronics are off and to switch-on J group Will be disabled after start-up. Will be enabled on SSRMS.

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Main Radiator – Ram, Set 1, Group 1, Bus B	77.8 @ 106.1V 88.2 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	4	2 thermostats in series+PDS Line 2B	No, by analysis	Double sided heaters glued to back side of radiator (2) and JPD side walls (2)	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 1, Group 2, Bus B	68.9 @ 106.1V 78.2 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	20	2 thermostats in series+PDS Line 2B	No, by analysis	Double sided heaters glued to JT crate main walls (10 x 2)	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 1, Group 3, Bus B	60.5 @ 106.1V 68.6 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	20	2 thermostats in series+PDS Line 2B	No, by analysis	Double sided heaters glued to J crate main walls (10 x 2)	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 1, Group 4, Bus B	51.8 @ 106.1V 58.8 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 2B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 1, Group 5, Bus B	77.8 @ 106.1V 88.2 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	3	2 thermostats in series+PDS Line 2B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 1, Group 6, Bus B	77.8 @ 106.1V 88.2 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	3	2 thermostats in series+PDS Line 2B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 2, Group 7, Bus B	69.1 @ 106.1V 78.4 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 5B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 2, Group 8, Bus B	69.1 @ 106.1V 78.4 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 5B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Main Radiator – Ram, Set 2, Group 9, Bus B	69.1 @ 106.1V 78.4 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 5B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 2, Group 10, Bus B	69.1 @ 106.1V 78.4 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	2	2 thermostats in series+PDS Line 5B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Ram, Set 2, Group 11, Bus B	34.6 @ 106.1V 39.2 @ 113V	106.1 (PVGF) 113 (ISS)	126.5	-8°C / 0°C	Dual element heater	1	2 thermostats in series+PDS Line 5B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup of all electronics but J group. Will be disabled after start-up. No power through PVGF.
Main Radiator – Wake, Group 1, Bus A	63.3	113	126.5	-10°C / +5°C	Dual element heater	3	2 thermostats in series + PDS Line 8A	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup and when electronics are off. Will be disabled after start-up.
Main Radiator – Wake, Group 2, Bus A	63.3	113	126.5	-10°C / +5°C	Dual element heater	3	2 thermostats in series + PDS Line 8A	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup and when electronics are off. Will be disabled after start-up.
Main Radiator – Wake, Group 1, Bus B	63.3	113	126.5	-10°C / +5°C	Dual element heater	3	2 thermostats in series + PDS Line 8B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup and when electronics are off. Will be disabled after start-up.
Main Radiator – Wake, Group 2, Bus B	63.3	113	126.5	-10°C / +5°C	Dual element heater	3	2 thermostats in series + PDS Line 8B	No, by analysis	Double sided heaters glued to back side of radiator	Needed for startup and when electronics are off. Will be disabled after start-up.
Cryo-cooler I - Primary LHP - BUSA	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Cryo-cooler I - Primary LHP- BUSB	4.0 on LHP + 2.8 on additional resistorson VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler I - Secondary LHP- BUSA	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler I - Secondary LHP- BUSB	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler II - Primary LHP- BUSA	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler II - Primary LHP- BUSB	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler II - Secondary LHP- BUSA	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-	3 (2 foil heaters and 1 wire-wound	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
					wound resistor	resistor)				
Cryo-cooler II - Secondary LHP- BUSB	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler III - Primary LHP- BUSA	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler III - Primary LHP- BUSB	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler III - Secondary LHP- BUSA	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler III - Secondary LHP- BUSB	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Cryo-cooler 0 - Primary LHP- BUSA	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler 0 - Primary LHP- BUSB	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler 0 - Secondary LHP- BUSA	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
Cryo-cooler 0- Secondary LHP- BUSB	4.0 on LHP + 2.8 on additional resistor on VC	113	126.5	+34C/+40C	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	1 thermostat + PDS A9	No, by analysis	Foil heater glued to Primary LHP evaporator. Resistor glued to VC.	Needed to startup LHP
TRDGB C-box pump canister Bus A	11.4	113	126.5	+10C/+15C	Kapton foil	2	1 thermostat + PDS Line A3 (shared thermostat with valves)	No	Glued to surface of pump canister	Enabled during operation.
TRDGB C-box pump canister Bus B	11.4	113	126.5	+10C/+15C	Kapton foil	2	1 thermostat + PDS Line B3 (shared thermostat with valves)	No		Enabled during operation.

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
TRDGB C-box valves Bus A	3.6	113	126.5	+10C/+15C	resistor	4	1 thermostat + PDS Line A3 (shared thermostat with canister)	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB C-box valves Bus B	3.6	113	126.5	+10C/+15C	resistor	4	1 thermostat + PDS Line B3 (shared thermostat with canister)	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB Lower 2-valve block Bus A	6.2	113	126.5	+10C/+15C	resistor	2	1 thermostat + PDS Line A3	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB Lower 2-valve block Bus B	6.2	113	126.5	+10C/+15C	resistor	2	1 thermostat + PDS Line B3	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB Upper 2-valve block Bus A	4.5	113	126.5	+10C/+15C	resistor	2	1 thermostat + PDS Line A3	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB Upper 2-valve block Bus B	4.5	113	126.5	+10C/+15C	resistor	2	1 thermostat + PDS Line B3	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB Vent valve Bus A	3.2	113	126.5	+10C/+15C	resistor	2	1 thermostat + PDS Line A3	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB Vent valve B Bus	3.2	113	126.5	+10C/+15C	resistor	2	1 thermostat + PDS Line B3	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB 4-valve Block Bus A	8	113	126.5	+10C/+15C	resistor	2	1 thermostat + PDS Line A3	No	Resistors glued on valve bracket	Enabled during operation.
TRDGB 4-valve Block Bus B	8	113	126.5	+10C/+15C	resistor	2	1 thermostat + PDS Line B3	No	Resistors glued on valve bracket	Enabled during operation.
CAB BUS A	98,2 (@ 113V)	113 ISS (we are not going to operate these heaters when we	126.5	-20C/-14C	Kapton Foil dual element heater	2	2 thermostats + PDS Line A8	No	Double sided heater glued to CAB housing	Needed to bring CAB unit to switch-on condition during extreme cold cases

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
		are on the SSRMS)								
CAB BUS B	98,2 (@ 113V)	113 ISS (we are not going to operate these heaters when we are on the SSRMS)	126.5	-20C/-14C	Kapton Foil dual element heater	2	2 thermostats + PDS Line B8	No	Double sided heater glued to CAB housing	Needed to bring CAB unit to switch-on condition during extreme cold cases
CAB LHP#1 Bus A	4.0 on LHP + 2.8 on additional resistor on Wake Rad	113	126.5	Not applicable	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	PDS Line A11	No, by analysis	Double sided heaters glued to CAB LHP evaporator. Resistor glued to Wake Radiator.	Needed to startup LHP
CAB LHP#1 Bus B	4.0 on LHP + 2.8 on additional resistor on Wake Rad	113	126.5	Not applicable	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	PDS Line B11	No, by analysis	Double sided heaters glued to CAB LHP evaporator. Resistor glued to Wake Radiator.	Needed to startup LHP
CAB LHP#2 Bus A	4.0 on LHP + 2.8 on additional resistor on Wake Rad	113	126.5	Not applicable	Dual element heaters and wire-wound resistor	3 (2 foil heaters and 1 wire-wound resistor)	PDS Line A11	No, by analysis	Double sided heaters glued to CAB LHP evaporator. Resistor glued to Wake Radiator.	Needed to startup LHP
CAB LHP#2 Bus B	4.0 on LHP + 2.8 on additional resistor on Wake Rad	113	126.5	Not applicable	Dual element heaters and wire-	3 (2 foil heaters and 1 wire-wound	PDS Line B11	No, by analysis	Double sided heaters glued to CAB LHP evaporator. Resistor glued to Wake Radiator.	Needed to startup LHP

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
					wound resistor	resistor)				
RICH, Ram (+Ram/Port) Bus A	15.4 @ 106.1V (at PVGF) 17.5 @ 113V (on ISS)	106.1 (at PVGF) 113 (on ISS)	126.5	-27C/-21C	Kapton Foil	2	1 thermostat + PDS Line A7	No	Double sided heater glued to octagonal structure	Enabled during operation.
RICH, Ram (+Ram/Port) Bus B	see above	see above	126.5	-27C/-21C	Kapton Foil	2	1 thermostat + PDS Line B7	No	Double sided heater glued to octagonal structure	Enabled during operation.
RICH, Port (+Port/Wake) Bus A	see above	see above	126.5	-27C/-21C	Kapton Foil	2	1 thermostat + PDS Line A7	No	Double sided heater glued to octagonal structure	Enabled during operation.
RICH, Port (+Port/Wake) Bus B	see above	see above	126.5	-27C/-21C	Kapton Foil	2	1 thermostat + PDS Line B7	No	Double sided heater glued to octagonal structure	Enabled during operation.
RICH, Wake (+Wake/Starboard) Bus A	see above	see above	126.5	-27C/-21C	Kapton Foil	2	1 thermostat + PDS Line A7	No	Double sided heater glued to octagonal structure	Enabled during operation.
RICH, Wake (+Wake/Starboard) Bus B	see above	see above	126.5	-27C/-21C	Kapton Foil	2	1 thermostat + PDS Line B7	No	Double sided heater glued to octagonal structure	Enabled during operation.
RICH, Starboard (+Starboard/Ram) Bus A	see above	see above	126.5	-27C/-21C	Kapton Foil	2	1 thermostat + PDS Line A7	No	Double sided heater glued to octagonal structure	Enabled during operation.
RICH, Starboard (+Starboard/Ram) Bus B	see above	see above	126.5	-27C/-21C	Kapton Foil	2	1 thermostat + PDS Line B7	No	Double sided heater glued to octagonal structure	Enabled during operation.
ECAL, Starboard Bus A	15,4 @ 106.1V at PVGF 17,5 @	106.1 (at PVGF) 113 (on ISS)	126.5	-18C/-12C	Kapton Foil	4	1 thermostat + PDS Line A1	No	Double sided heater glued to back of radiator structure	Enabled during operation.

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
	113V on ISS									
ECAL, Starboard Bus B	see above	113	126.5	-18C/-12C	Kapton Foil	4	1 thermostat + PDS Line B1	No	Double sided heater glued to back of radiator structure	Enabled during operation.
ECAL, Wake Bus A	see above	113	126.5	-18C/-12C	Kapton Foil	4	1 thermostat + PDS Line A1	No	Double sided heater glued to back of radiator structure	Enabled during operation.
ECAL, Wake Bus B	see above	113	126.5	-18C/-12C	Kapton Foil	4	1 thermostat + PDS Line B1	No	Double sided heater glued to back of radiator structure	Enabled during operation.
ECAL, Port Bus A	see above	113	126.5	-18C/-12C	Kapton Foil	4	1 thermostat + PDS Line A1	No	Double sided heater glued to back of radiator structure	Enabled during operation.
ECAL, Port Bus B	see above	113	126.5	-18C/-12C	Kapton Foil	4	1 thermostat + PDS Line B1	No	Double sided heater glued to back of radiator structure	Enabled during operation.
ECAL, Ram Bus A	see above	113	126.5	-18C/-12C	Kapton Foil	4	1 thermostat + PDS Line A1	No	Double sided heater glued to back of radiator structure	Enabled during operation.
ECAL, Ram Bus B	see above	113	126.5	-18C/-12C	Kapton Foil	4	1 thermostat + PDS Line B1	No	1 Double sided heater glued to each of the two E-crates	Enabled during operation.
E-crate (E-0) Bus A	26.5 @ 106.1V at PVGF 30.0 @ 113V on ISS	106.1 (at PVGF) 113 (on ISS)	126.5	-18C/-12C	Kapton Foil	1	1 thermostat + PDS Line A6	No	1 Double sided heater glued to the bottom plate of the E-crate housing	
E-crate (E-0) Bus B	see above	see above	126.5	-18C/-12C	Kapton Foil	1	1 thermostat + PDS Line B6	No	1 Double sided heater glued to the bottom plate of the E	
E-crate (E-1) Bus A	see above	see above	126.5	-18C/-12C	Kapton Foil	1	1 thermostat + PDS Line A6	No	1 Double sided heater glued to the bottom plate of the E	
E-crate (E-1) Bus B	see above	see above	126.5	-18C/-12C	Kapton Foil	1	1 thermostat + PDS Line B6	No	1 Double sided heater glued to the bottom plate of the E	

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Lower TOF, +X Bus A	6.6 @ 106.1 at PVGF 7.5 @ 113 on ISS	106.1 (at PVGF) 113 (on ISS)	126.5	-27C/-21C	Kapton Foil	1	1 thermostat + PDS Line A7	No	1 Double sided heater glued to TOF structure	Enabled during operation.
Lower TOF, +X Bus B	See above	see above	126.5	-27C/-21C	Kapton Foil	1	1 thermostat + PDS Line B7	No	1 Double sided heater glued to TOF structure	Enabled during operation.
Lower TOF, +Y Bus A	8.3 @ 106.1 at PVGF 9.4 @ 113 on ISS	106.1 (at PVGF) 113 (on ISS)	126.5	-27C/-21C	Kapton Foil	3	1 thermostat + PDS Line A7	No	1 Double sided heater glued to TOF structure	Enabled during operation.
Lower TOF, +Y Bus B	See above	see above	126.5	-27C/-21C	Kapton Foil	3	1 thermostat + PDS Line B7	No	1 Double sided heater glued to TOF structure	Enabled during operation.
Lower TOF, -X Bus A	6.6 @ 106.1 at PVGF 7.5 @ 113 on ISS	106.1 (at PVGF) 113 (on ISS)	126.5	-27C/-21C	Kapton Foil	1	1 thermostat + PDS Line A7	No	1 Double sided heater glued to TOF structure	Enabled during operation.
Lower TOF, -X Bus B	see above	see above	126.5	-27C/-21C	Kapton Foil	1	1 thermostat + PDS Line B7	No	1 Double sided heater glued to TOF structure	Enabled during operation.
Lower TOF, -Y Bus A	8.3 @ 106.1 at PVGF 9.4 @ 113 on ISS	106.1 (at PVGF) 113 (on ISS)	126.5	-27C/-21C	Kapton Foil	3	1 thermostat + PDS Line A7	No	1 Double sided heater glued to TOF structure	Enabled during operation.
Lower TOF, -Y Bus B	See above	See above	126.5	-27C/-21C	Kapton Foil	3	1 thermostat + PDS Line B7	No	1 Double sided heater glued to TOF structure	Enabled during operation.
EHV & RHV Bricks (10 High Voltage Boxes total) Bus A	66 @ 106.1 at PVGF 75 @ 113 on ISS	106.1 (at PVGF) 113 (on ISS)	126.5	-18C/-12C	Kapton Foil	10	1 thermostat per brick + PDS Line A6	No	1 Double sided heater glued inside each brick box	
EHV & RHV Bricks (10 total)	see above	see above	126.5	-18C/-12C	Kapton Foil	10	1 thermostat per brick + PDS Line B6	No	1 Double sided heater glued inside each brick box	

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Bus B										
Accu Wall P-Box TTCS-P A	36.0	26.5	29.5	variable	Kapton Foil	1	3 x PT1000s	No	Glued on the Accu Wall	Ground Test, Control
Accu Wall P-Box TTCS-P B	36.0	26.5	29.5	variable	Kapton Foil	1	3 x PT1000s	No	Glued on the Accu Wall	Ground Test, Control
Accu Wall S-Box TTCS-S	36.0	26.5	29.5	variable	Kapton Foil	1	3 x PT1000s	No	Glued on the Accu Wall	Ground Test, Control
Accu Wall S-Box TTCS-S	36.0	26.5	29.5	variable	Kapton Foil	1	3 x PT1000s	No	Glued on the Accu Wall	Ground Test, Control
Accu Heat Pipe P-Box TTCS-P	33.6	26.5	29.5	variable	Wire	1	Thermostats	No	Soldering onto the Accu heat pipe	Flight Test, Control
Accu Heat Pipe S-Box TTCS-P	33.6	26.5	29.5	variable	Wire	1	Thermostats	No, by analysis	Soldering onto the Accu heat pipe	Flight Test, Control
Accu Heat Pipe S-Box TTCS-S	33.6	26.5	29.5	variable	Wire	1	Thermostats	No, by analysis	Soldering onto the Accu heat pipe	Flight Test, Control
Accu Heat Pipe S-Box TTCS-S	33.6	26.5	29.5	variable	Wire	1	Thermostats	No, by analysis	Soldering onto the Accu heat pipe	Flight Test, Control
Pre-Heater, TTCS-P	8	26.5	29.5	-	Wire	1	TTCE Bus A	No, by analysis	Soldering onto the Pre-heater copper structure	Used to assure that liquid CO2 entering the TTCS evaporator is at saturation temperature
Pre-Heater, TTCS-P	8	26.5	29.5	-	Wire	1	TTCE Bus A	No, by analysis	Soldering onto the Pre-heater copper structure	Used to assure that liquid CO2 entering the TTCS evaporator is at saturation temperature
Pre-Heater, TTCS-P	8	26.5	29.5	-	Wire	1	TTCE Bus B	No, by analysis	Soldering onto the Pre-heater copper structure	Used to assure that liquid CO2 entering the TTCS evaporator is at saturation temperature
Pre-Heater,	8	26.5	29.5	-	Wire	1	TTCE Bus B	No, by	Soldering onto the Pre-	Used to assure that liquid

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
TTCS-P								analysis	heater copper structure	CO2 entering the TTCS evaporator is at saturation temperature
Pre-Heater, TTCS-S	8	26.5	29.5	-	Wire	1	TTCE Bus A	No, by analysis	Soldering onto the Pre-heater copper structure	Used to assure that liquid CO2 entering the TTCS evaporator is at saturation temperature
Pre-Heater, TTCS-S	8	26.5	29.5	-	Wire	1	TTCE Bus A	No, by analysis	Soldering onto the Pre-heater copper structure	Used to assure that liquid CO2 entering the TTCS evaporator is at saturation temperature
Pre-Heater, TTCS-S	8	26.5	29.5	-	Wire	1	TTCE Bus B	No, by analysis	Soldering onto the Pre-heater copper structure	Used to assure that liquid CO2 entering the TTCS evaporator is at saturation temperature
Pre-Heater, TTCS-S	8	26.5	29.5	-	Wire	1	TTCE Bus B	No, by analysis	Soldering onto the Pre-heater copper structure	Used to assure that liquid CO2 entering the TTCS evaporator is at saturation temperature
Start-up, TTCS-P	43.8	26.5	29.5	+60/+80	Wire	1	3 Thermostats in series	No, by analysis	Soldering onto the Heat Exchangers	Heats CO2 above minimum Tracker switch on temperature
Start-up, TTCS-P	43.8	26.5	29.5	+60/+80	Wire	1	3 Thermostats in series	No, by analysis	Soldering onto the Heat Exchangers	Heats CO2 above minimum Tracker switch on temperature
Start-up, TTCS-S	43.8	26.5	29.5	+60/+80	Wire	1	3 Thermostats in series	No, by analysis	Soldering onto the Heat Exchangers	Heats CO2 above minimum Tracker switch on temperature
Start-up, TTCS-S	43.8	26.5	29.5	+60/+80	Wire	1	3 Thermostats in series	No, by analysis	Soldering onto the Heat Exchangers	Heats CO2 above minimum Tracker switch on temperature
Cold Orbit, TTCS-P	54.0	26.5	29.5	+60/+80	Wire	1	TTCE Bus A	No, by analysis	Soldering onto the Cold-Orbit copper structure	Prevent freezing in the condenser
Cold Orbit, TTCS-P	54.0	26.5	29.5	+60/+80	Wire	1	TTCE Bus B	No, by analysis	Soldering onto the Cold-Orbit copper structure	Prevent freezing in the condenser
Cold Orbit, TTCS-S	54.0	26.5	29.5	+60/+80	Wire	1	TTCE Bus A	No, by analysis	Soldering onto the Cold-Orbit copper structure	Prevent freezing in the condenser

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Cold Orbit, TTCS-S	54.0	26.5	29.5	+60/+80	Wire	1	TTCE Bus B	No, by analysis	Soldering onto the Cold-Orbit copper structure	Prevent freezing in the condenser
TTCS Liquid Lines, RAM P	15.6	26.5	29.5	+32C/+54C	1*Wire 1*Foil	2	2 Thermostats in series + PT100 & TTCE Bus A	No, By Test & Analysis	Wire wrapped around Capillary Liquid Lines, retention by lock wire. Foil glues on condenser plate	Need to thaw CO2 in TTCS condenser lines after power outage
TTCS Liquid Lines, RAM P	15.6	26.5	29.5	+32C/+54C	1*Wire 1*Foil	2	2 Thermostats in series + PT100 & TTCE Bus A	No, By Test & Analysis	Wire wrapped around Capillary Liquid Lines, retention by lock wire. Foil glues on condenser plate	Need to thaw CO2 in TTCS condenser lines after power outage
TTCS Liquid Lines, RAM S	15.6	26.5	29.5	+32C/+54C	1*Wire 1*Foil	2	2 Thermostats in series + PT100 & TTCE Bus A	No, By Test & Analysis	Wire wrapped around Capillary Liquid Lines, retention by lock wire. Foil glues on condenser plate	Need to thaw CO2 in TTCS condenser lines after power outage
TTCS Liquid Lines, RAM S	15.6	26.5	29.5	+32C/+54C	1*Wire 1*Foil	2	2 Thermostats in series + PT100 & TTCE Bus A	No, By Test & Analysis	Wire wrapped around Capillary Liquid Lines, retention by lock wire. Foil glues on condenser plate	Need to thaw CO2 in TTCS condenser lines after power outage
TTCS Liquid Lines, WAKE P	15.6	26.5	29.5	+32C/+54C	1*Wire 1*Foil	2	2 Thermostats in series + PT100 & TTCE Bus A	No, By Test & Analysis	Wire wrapped around Capillary Liquid Lines, retention by lock wire. Foil glues on condenser plate	Need to thaw CO2 in TTCS condenser lines after power outage
TTCS Liquid Lines, WAKE P	15.6	26.5	29.5	+32C/+54C	1*Wire 1*Foil	2	2 Thermostats in series + PT100 & TTCE Bus A	No, By Test & Analysis	Wire wrapped around Capillary Liquid Lines, retention by lock wire. Foil glues on condenser plate	Need to thaw CO2 in TTCS condenser lines after power outage
TTCS Liquid Lines, WAKE S	15.6	26.5	29.5	+32C/+54C	1*Wire 1*Foil	2	2 Thermostats in series + PT100 & TTCE Bus A	No, By Test & Analysis	Wire wrapped around Capillary Liquid Lines, retention by lock wire. Foil glues on condenser plate	Need to thaw CO2 in TTCS condenser lines after power outage

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
TTCS Liquid Lines, WAKE S	15.6	26.5	29.5	+32C/+54C	1*Wire 1*Foil	2	2 Thermostats in series + PT100 & TTCE Bus A	No, By Test & Analysis	Wire wrapped around Capillary Liquid Lines, retention by lock wire. Foil glues on condenser plate	Need to thaw CO2 in TTCS condenser lines after power outage
TTCS-P Box heater										Deleted From Design
TTCS-P Box heater										Deleted From Design
TTCS-S Box heater										Deleted From Design
TTCS-S Box heater										Deleted From Design
TRDGB CO2 Tank	10.8	26.5		+39C/+41C	Kapton foil	8	4 thermostats in series + UG-crate A	Yes*	Heaters glued to surface of carbon-fiber overwrapped tank.	*Needed to maintain CO2 above saturation temperature for pressure measurement. Failed "ON" heaters could cause excedence of maximum design temperature (+65C). Failed "OFF" heaters cause no hazard.
TRDGB CO2 Tank	10.8	26.5		+39C/+41C	Kapton foil	8	4 thermostats in series + UG-crate B	Yes*	Heaters glued to surface of carbon-fiber overwrapped tank.	*Needed to maintain CO2 above saturation temperature for pressure measurement. Failed "ON" heaters could cause excedence of maximum design temperature (+65C). Failed "OFF" heaters cause no hazard.
TRDGB Xe Tank	7.84	26.5		+26C/+28C	Kapton foil	8	4 thermostats in series + UG-crate A	Yes*	Heaters glued to surface of carbon-fiber overwrapped tank.	*Needed to maintain Xe above saturation temperature for pressure measurement. Failed "ON" heaters could cause excedence of maximum design temperature (+65C). Failed "OFF" heaters cause no hazard.

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
TRDGB Xe Tank	7.84	26.5		+26C/+28C	Kapton foil	8	4 thermostats in series + UG-crate B	Yes*	Heaters glued to surface of carbon-fiber overwrapped tank.	*Needed to maintain Xe above saturation temperature for pressure measurement. Failed "ON" heaters could cause excedence of maximum design temperature (+65C). Failed "OFF" heaters cause no hazard.
TRDGB Tower Bracket Assy	7.44	26.5		+10C/+15C	Resistors	2	1 thermostat + UG-crate A	No		Needed to maintain valves above operating limit.
TRDGB Tower Bracket Assy	7.44	26.5		+10C/+15C	Resistors	2	1 thermostat + UG-crate B	No		Needed to maintain valves above operating limit.
EBCS, Primary	50 (@120V)	113	126.5	-10C/-3.3C		2	2 thermostats in series per element, Power Line A	No		Maintains EBCS above survival limits. GFE.
EBCS, Secondary	50 (@120V)	113	126.5	-18.3C/-13.3C		2	2 thermostats in series per element, Power Line B	No		Maintains EBCS above survival limits. GFE.
TRD M-Structure, Ram side, Bus A	15.38	113	126.5	+10 C/ +20 C	Resistor	4 resistors in parallel	4 thermostats (two in parallel in series with other two in parallel)	No	Resistors glued to M-Structure	Maintain TRD within “best performace” range
TRD M-Structure, Ram side, Bus B	15.38	113	126.5	+10 C/ +20 C	Resistor	4 resistors in parallel	4 thermostats (two in parallel in series with other two in parallel)	No	Resistors glued to M-Structure	Maintain TRD within “best performace” range
TRD M-Structure, Wake side, Bus A	15.38	113	126.5	+10 C/ +20 C	Resistor	4 resistors in parallel	4 thermostats (two in parallel in series with other two in parallel)	No	Resistors glued to M-Structure	Maintain TRD within “best performace” range
TRD M-Structure, Wake side, Bus B	15.38	113	126.5	+10 C/ +20 C	Resistor	4 resistors in parallel	4 thermostats (two in parallel in series with other two in parallel)	No	Resistors glued to M-Structure	Maintain TRD within “best performace” range
TRD M-	15.38	113	126.5	+10 C/ +20 C	Resistor	4 resistors	4 thermostats	No	Resistors glued to M-	Maintain TRD within “best

AMS-02 THERMAL CONTROL SYSTEM (TCS) HEATER PROPERTIES

Heater String	Power at Min Voltage (W)	Min Voltage (Vdc)	Max Voltage (Vdc)	Set Point	Type	Number of elements	Control	Safety Critical	Mounting	Comments
Structure, Port side, Bus A						in parallel	(two in parallel in series with other two in parallel)		Structure	performace" range
TRD M-Structure, Port side, Bus B	15.38	113	126.5	+10 C/ +20 C	Resistor	4 resistors in parallel	4 thermostats (two in parallel in series with other two in parallel)	No	Resistors glued to M-Structure	Maintain TRD within "best performace" range
TRD M-Structure, Starboard side, Bus A	15.38	113	126.5	+10 C/ +20 C	Resistor	4 resistors in parallel	4 thermostats (two in parallel in series with other two in parallel)	No	Resistors glued to M-Structure	Maintain TRD within "best performace" range
TRD M-Structure, Starboard side, Bus B	15.38	113	126.5	+10 C/ +20 C	Resistor	4 resistors in parallel	4 thermostats (two in parallel in series with other two in parallel)	No	Resistors glued to M-Structure	Maintain TRD within "best performace" range